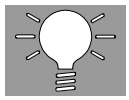
Functional Description



2

Chapter 2

explains the functional principle including the functions of the individual assemblies always under normal conditions without any problems (nominal functional sequence).

Furthermore it describes the structure and function of specific individual assemblies.

Chapter 2

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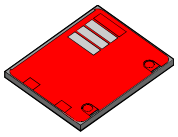
1 Digitizer as a part of the ADC System

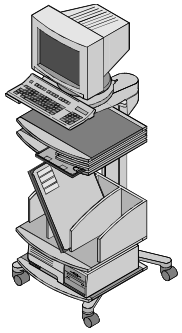
1.1 ADC System Components



ADC Cassette with image plate inside

The ADC cassette is the “container” for the image plate. During the handling outside the Digitizer (e.g. exposing the plate) the image plate is in the cassette. It is only opened inside the Digitizer. The ADC cassette has an internal chip card which holds the cassette, patient, examination and routing data belonging to a certain X-ray exposure. The data put together are called demographic data.

The image plate takes the place of the X-ray film in a conventional system. It receives the X-Ray radiation and “stores” a latent image. The image plates can be reused thousands of times. The actual restriction of utilization is the mechanical robustness.

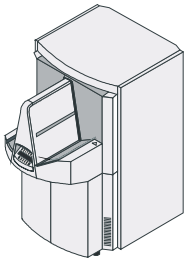


ADC Identification Station

The Identification Station is used to write the cassette, patient, examination and routing data to the cassette chip. This data can be entered manually or by retrieving the data from a Hospital or Radiology Information System (HIS/RIS).

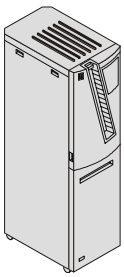
By means of a so called Identification Tablet (ID-Tablet) the data is transferred to the chip. Writing and reading is done by means of radio frequency in a contact less manner.

The Identification software is an AGFA product and is running on MS-Windows based operating systems (WIN95/98, WinNT4.0).



ADC Digitizers (Compact Plus / Compact / Solo)

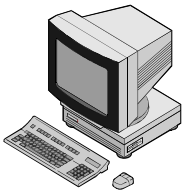
The Digitizer is used to read the latent image in the image plate. After the ADC cassette is exposed and identified it is inserted into the Digitizer. The Digitizer reads the data on the cassette chip, opens the cassette, takes out the image plate and scans it. The latent image on the image plate is stimulated by means of a laser beam to emit light according to X-ray exposure.



The data from the cassette chip is used to set the scan parameters correctly (e.g. speed class, image plate size, etc.) for this individual X-ray exposure.

The emitted light is converted into voltage and then digitalized into a 12/14bit, square root compressed raw image. This image is transmitted together with the chip data on the fly via Ethernet to the Processing Station. A backup of that image is made on the internal hard disk in parallel to retransmit the image in case of transmission problems. The output format of the Digitizer is DICOM SCU-CR.

After scanning / transmitting is finished the image plate is erased with very bright light to make it ready for the next exposure. It is put back into the cassette and a status flag on the cassette chip is set from “EXPOSED” to “ERASED”. The cassette is returned to the user and is ready for the next examination.



ADC Processing Station

The Processing Station receives the raw image from the Digitizer. Every incoming image runs through an image processing. The processed images are stored on the internal hard disk(s) on the Processing Station.

However, the Processing Station only provides short term storage. The final archiving must be realized either by hardcopies or a PACS.

Further on, the Processing Station decodes the routing data and sends the image data to the selected destinations (e.g. Preview, Printer, PACS). The Preview Station has the highest priority in the sending list.

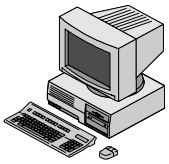
A Softcopy can be sent to an Archive or Review Station with 8 or 12 bit. To print a Hardcopy a 8 bit format is used.

For the Processing Station a lot of licensed software options (e.g. Interactive Image Processing, Annotation, Smart Print, etc.) exist.

The Processing Station is a Solaris (UNIX- OS) based SUN workstation with the **M**edical **I**mage **M**anagement **O**perating **S**ystem of **A**GFA (MIMOSA) installed.

ADC QS Server Station

The ADC QS (Quality System) Server Station is a NT-based Processing Station with the ADC Quality-System software installed.



ADC Preview Station

The Preview Station software is not a mandatory part of the system. However, in most of the installations this feature is used to get a fast view on the just scanned image, therefore the Processing Station is sending a 8 bit preview image to the Preview Station. This allows the user to release the patient rather quickly from the examination session.

Several Preview Stations can be served by one Processing Station. The Preview Station software may run on the same PC-Hardware as the Identification Station software, but it may also run on a separate PC.

The Preview software is an AGFA product and runs on MS-Windows based operating systems (WIN95/98, WinNT4.0).

ADC QS Client Station

The ADC QS (Quality System) Client Station allows identification and basic viewing.

1.2 Work Flow of the ADC System

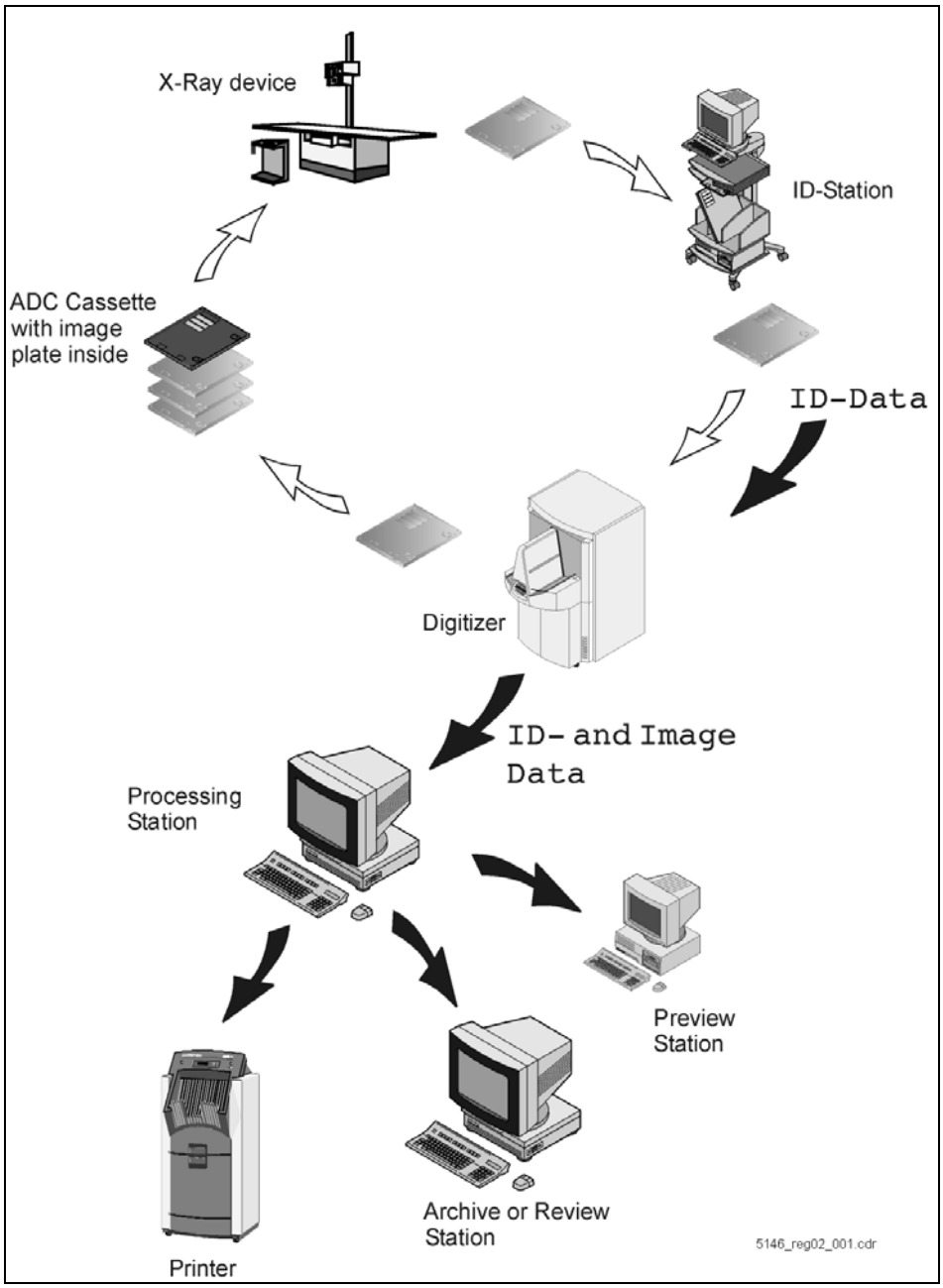


Figure 1

2 ADC Cassettes

The principle function of the digitizer is close connected to the structure of the ADC Cassettes. The digitizer accepts only ADC Compact and Solo Cassettes. All other cassettes, like ADC 70, are refused.

2.1 Standard Cassette

The cassette must always be inserted into the digitizer in the correct orientation to make it possible to identify and handle the cassette!

The ADC label and the label, showing the size of the contained image plate, are put on for the identification by the user.

The metal label is detected by the digitizer to identify the cassette as an ADC cassette.

The demographic data is at the ID-Station transferred by no-touch radio frequency tagging to the ID-Chip and is read out in the digitizer. The data is in that way always linked to the image.

For protection against electrostatic charging and mechanical damage the inner lining of the cassette is made of felt.

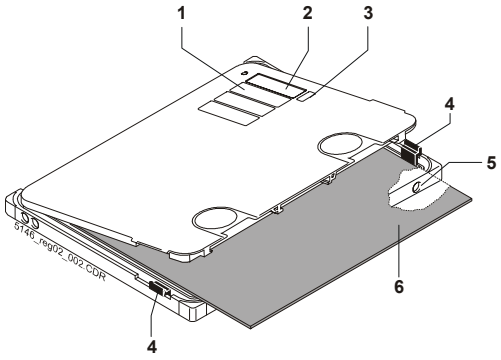


Figure 2

1 ADC label

2 ID-Chip carries demographic data

3 Label showing size of Image Plate

4 Sliders to prevent from usage in film handling devices

5 Metal label – silver dot – identifies an ADC Cassette

6 ADC Image Plate (gray surface up, white surface down)

2.2 ADC MD30 Image Plate Principle

The image plate laying in the cassette consists of five different layers:

The phosphor layer is “storing” the picture information as energy .

The EBC top coat provides a smooth surface of the image plate to reach a good signal-to-noise ratio.

Combination of white support layer and blue anti-halo layer increases the sensitivity. The anti-halo layer lets through the stimulated light but blocks laser light.

The laminate is needed as base material.

Image Plate Structure

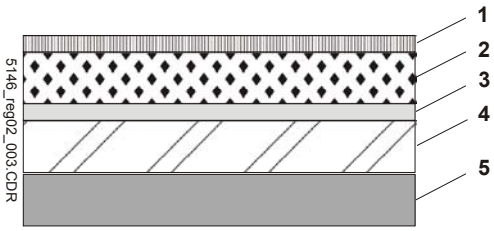


Figure 3

1 Protective EBC (electron-beam-cured) top coat

2 Phosphor layer

3 Anti-halo layer, blue

4 Support P.E.T, white

5 Laminate

2.3 Mammography Cassette

The ADC Mammo Cassette is only foreseen for mammography of breast implants and must not be used for other mammographic applications or diagnostics!

Identification:
The cassette is labeled with “Mammo” on both sides and with “Implants” on the tube side.
The cassette is preinitialised as a Mammo Cassette, but if the identification is lost, it can be given via the ID Station.

Formats:
The ADC Mammo Cassette is available in two formats:

- 18 cm x 24 cm
- 24 cm x 30 cm

Specification:
The ADC Mammo Cassette contains normally a regular ADC MD30 image plate. This type of image plate has a special phosphor layer which results in a high dynamic range. The cassette is equipped with a special hinge in order to reduce the chest wall distance to the image plate.
The Mammo Cassette is intended to follow up implants (silicone, prosthesis) to check for position, leaks or calcifications.

2.4 Asymmetric Cassette

Identification:

A Cassette for asymmetric scanning can be identified by a red hatching covering less than the half of the cassette side. (see beside)

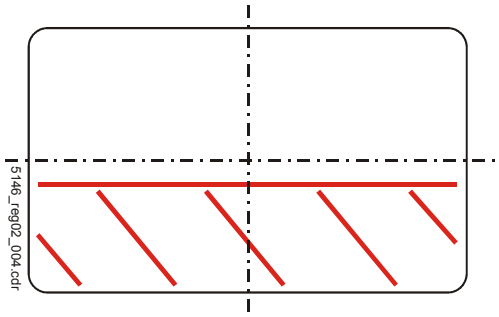


Figure 4

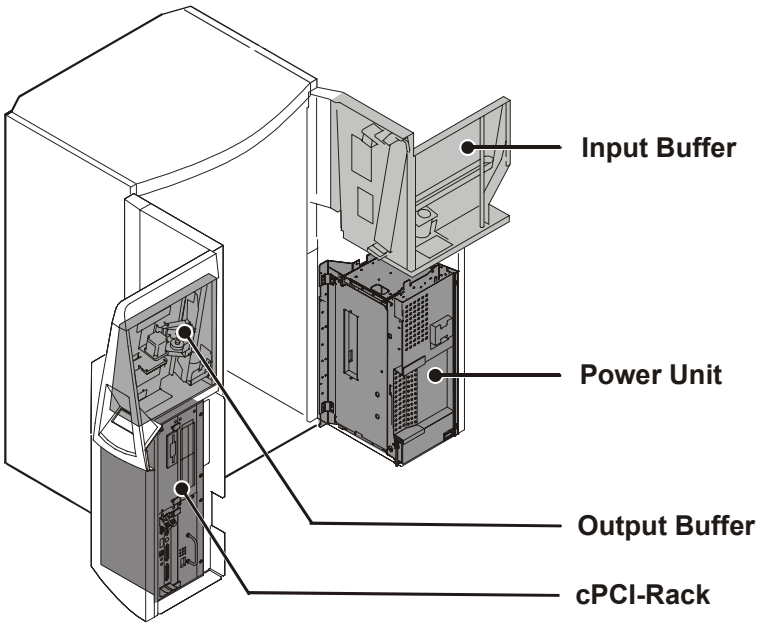
Formats:
The ADC Asymmetric Cassette is available in:

- 21 cm x 43 cm (asymmetric partial scan of dedicated 35 x 43 cassettes)

Specification:
The Asymmetric Cassette is dedicated for X-ray exposures where no centered positioning of the part of the body is possible (e.g. side view of a spinal column).

3 Modular Structure of the Digitizer

3.1 Overview of Modules



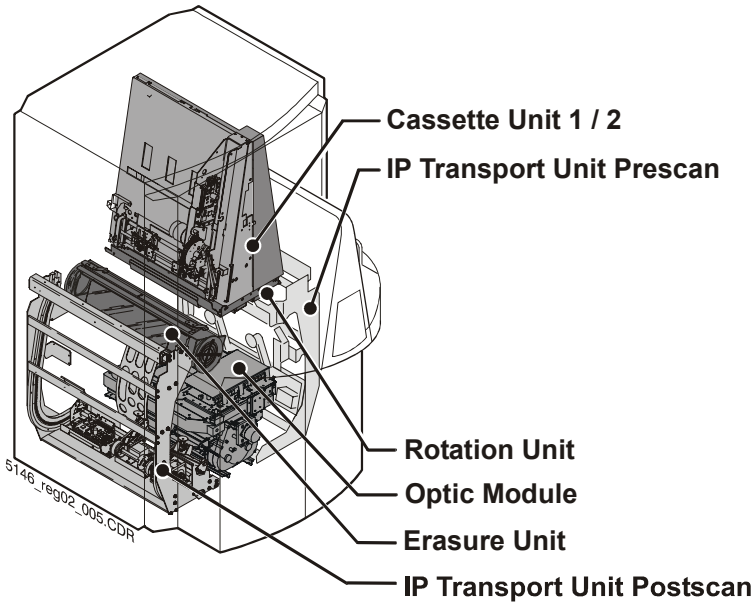


Figure 5

3.2 Input Buffer

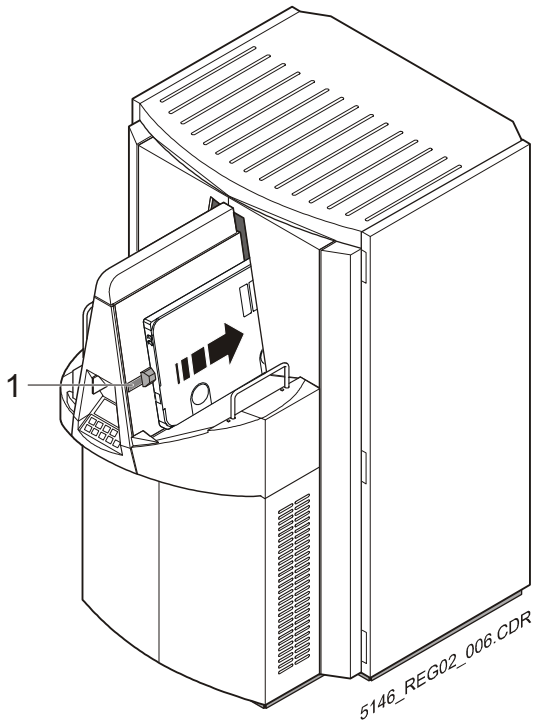


Figure 6

1 Transport belt

The Input Buffer has a capacity of 10 cassettes which can be put at the same time before the door. The cassettes are detected and the machine cycle is started with the first one. To transport the cassette inside the digitizer the transport belt shifts the cassette, the feed gate opens and the RF-Tag reader and the antenna read out the ID- and image specific data.

After the data is read out the transport roller of the cassette module, which is at the input position, takes over the movement of the cassette.

3.3 Power Unit

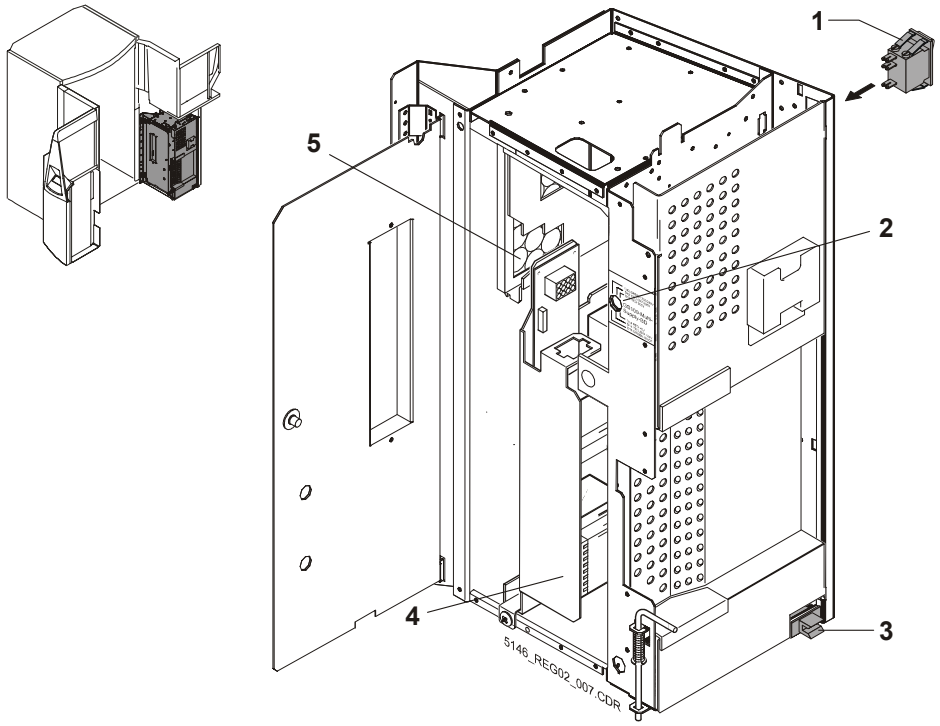


Figure 7

1 Main switch with over current protection
2 LEDs of Multi Supply Board
3 Interlock switch
4 Transformers
5 Filter of power unit fan

The power supply of the Power Unit is a single phase System, means the cable connection is a common inlet connector for non-heating apparatus. The supply voltage for the Power Unit is automatically detected. Therefore for installation it is not necessary to change any setting manually, but has to be checked before the first use.

If the interlock switch is active, all the power supplies of mechanical parts and the laser are interrupted, for safety during service interventions. The power supply of the cPCI-Rack is placed in the rack itself, so e.g. software updates can be done although the right door of the power unit is open and the interlock switch is active.

The Power Unit consists of the following main components:

- Multi Supply Board
- Erasure Control Board
- Current Sense Board
- Stepper Motor Transformers
- Erasure Transformer

3.3.1 Multi Supply Board

The Multi Supply Board (MS-Board) controls the mechanical periphery of the digitizer and protects the stepper motor cards. The supply voltage is detected by the board and errors are displayed by LEDs.

The following components are controlled by the IO-Bus of the board: The two vacuum pumps with two magnetic valves on the IP transport units, the parking position function by using solenoids at the IP transport unit postscan, the fan of the erasure unit and of the power unit and the voltage selection between 200V, 208V and 230/240V.

LEDs on the inner side of right door at the power unit show the status of the supply voltages of the power unit:

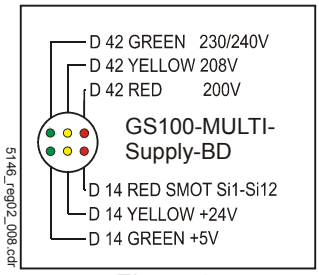


Figure 8

D 42 green LED on:	Supply voltage is 230/240V
D 42 yellow LED on:	Supply voltage is 208V
D 42 red LED on:	Supply voltage is 200V
D 14 red LED on:	Fuses of stepper motor boards Si 1 – Si 12 are okay
D 14 yellow LED on:	+24V from simple switcher
D 14 green LED on:	+5V from IO-Bus

Additional LEDs are visible if right door and power unit housing is open:

D19 – D32 red LEDs are corresponding to stepper motor fuses where they are placed next to. The stepper motor supply is protected with a fuse on every stepper motor board itself (12 in total). The status is shown with a green LED on the side of the power unit (see figure 8).
D 33 green LED is corresponding to the fuse (Si13) of power supply of simple switcher, which is placed next to the fuse.

Normal status:
The status of the LEDs, after switching on the digitizer with active interlock switch and without any error, is:

D19 to D33 LED on immediately,
D14 yellow LED on immediately,
D14 red LED on immediately,
D14 green LED on six seconds after switch on.
D42 green LED on immediately, but after initialization of the supply voltage of the digitizer one of the three D42 LEDs is on, but always only one.

Example:

Status of the LEDs after initialization of the supply voltage of 208V and more than six seconds after switch on.

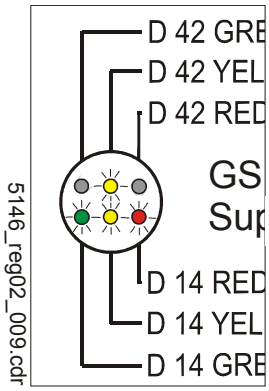


Figure 9

3.3.2 Erasure Control Board

The Erasure-Control-Board controls five transformers to supply the erasure lamps with power. The lamps are controlled in pairs, so one transformer supplies two lamps. Also the temperature of the erasure unit is controlled, if the detected temperature is lower than 85°C (185°F), the erasure process can start. If the temperature is higher than 85°C (185°F), the process is delayed until temperature has dropped below 75°C (167°F). During the delay the erasure unit fan cools the module.

The failure of a lamp is detected by the current sense board, which is also part of the power unit and is connected to the Erasure-Control-Board.

3.4 Output Buffer

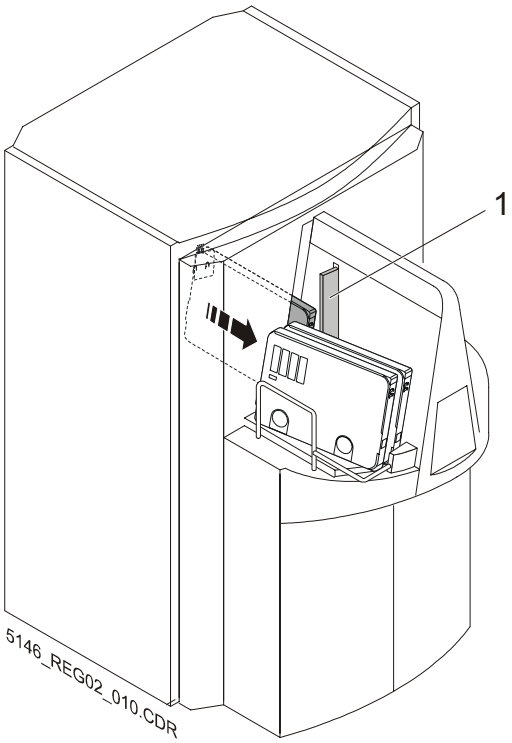


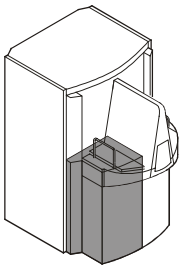
Figure 10

1 Lever

The Output Buffer has a capacity of 10 cassettes, like the Input Buffer. The transport rollers at the gate move the cassette outside. To avoid blocking when one cassette is following after another a lever pushes the cassettes which already lay outside in the buffer aside.

The cassettes which are going out are detected and after the last one the machine cycle stops.

3.5 cPCI-Rack



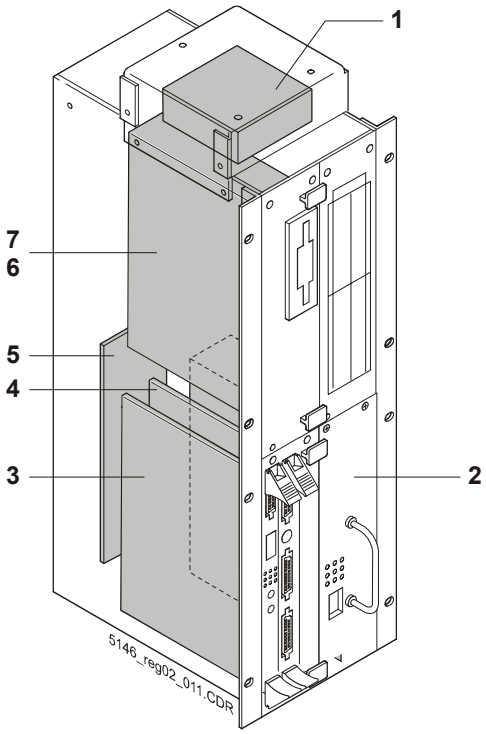


Figure 11

1 cPCI Rack Fan
2 cPCI Power Supply
3 CPU Ariel
4 Scan Master Board
5 Backplane
6 Hard disk
7 Floppy drive

The cPCI-Rack (**c**ompact **P**eripheral **C**omponent **I**nterconnect) consists of the processing unit CPU, the Scan Master Board, the Power Supply of the cPCI-Rack, a floppy drive and a hard disk. On top of the rack the fan for cooling the cPCI-Rack is mounted and on the back the backplane with all the connectors is placed.

3.5.1 CPU-Ariel

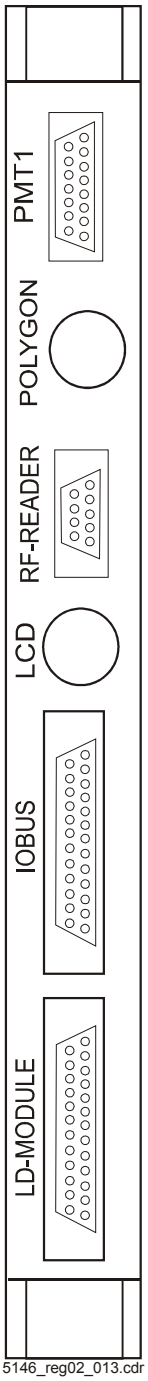
The CPU (**C**entral **P**rocessing **U**nit) is a Power PC and is working with an operating system called Ariel. The interfaces to the service and the Ethernet are placed on the front plane.

Connector (female) to Service Interface (RS232)	**Service:** Serial debug port connector, SuperIO and DUART
Connector to Fast Ethernet	**Fast Ethernet Controller:** RJ45 connector, Fast Ethernet with 10 to 100 Mbit/s
LED (3 green, 2 yellow, 1 red) Software control	Software controllable with Portex tool
LED (FPGA NOT Conf. Green, TRAFFIC yellow, Ethernet LINK red) Hardware control	Hardware related signaling: Ethernet Traffic – yellow LED Ethernet linked – red LED FPGA not configured – green LED
Halt Switch	HALT: Abort action
Reset Switch	RESET: Global reset

Figure 12

3.5.2 Scan Master Board

The Scan Master Board controls the main functions of the digitizer which are related to the image data acquisition. The board has to support two operating levels, low resolution and high resolution. Therefore timing, frequency and converters need to be controlled.



Connector (female) to Photomultiplier Tube

Photomultiplier Tube Control:
Controls the Photomultiplier itself, the high voltage settings and receives the current/voltage (I/V) converter signal.

Connector (female) to Polygon

Polygon Control:
Controls via the Polygon the deflection of the laser beam on the image plate, controls the rotational speed and detects the facets.

Connector (male) to RF-Reader

RF-Tag Reader Control:
Controls the transmitter and receiver signals for reading out demographic data of the ADC Cassette.

Connector (female) to User terminal

User terminal Control:
Controls the user terminal via a 20 mA interface.

Connector (female) to IO-Bus

IO-BUS Control:
Provides the IO-BUS with power and is connected via eight data lines and three control lines to the IO-BUS.

Connector (male) to Laser Diode Module

Laser diode Module Control:
Controls the power supply of both laser diodes of the laser module, controls the power switch of the laser diodes, controls Begin-of-Line Signal and Laser-Power-Monitor board.

Figure 13

3.5.3 cPCI Power Supply

Legend to the LEDs below, showing the Output voltages

Green LEDs to monitor power supply

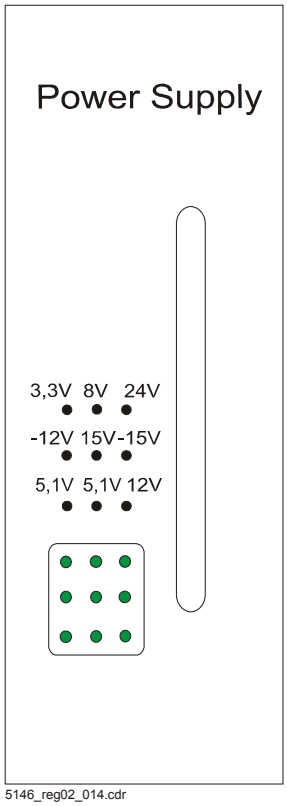


Figure 14

During normal operation the LEDs monitor 5,1V and 3,3V voltage levels.

The power supply of the cPCI Rack is not interrupted by the interlock switch. This independent supply makes it possible to update software or work out other actions at the rack while both doors of the digitizer are open.

3.5.4 Hard disk

The gray rectangle in the partition map marks the directories which are only necessary for remote control via http access.

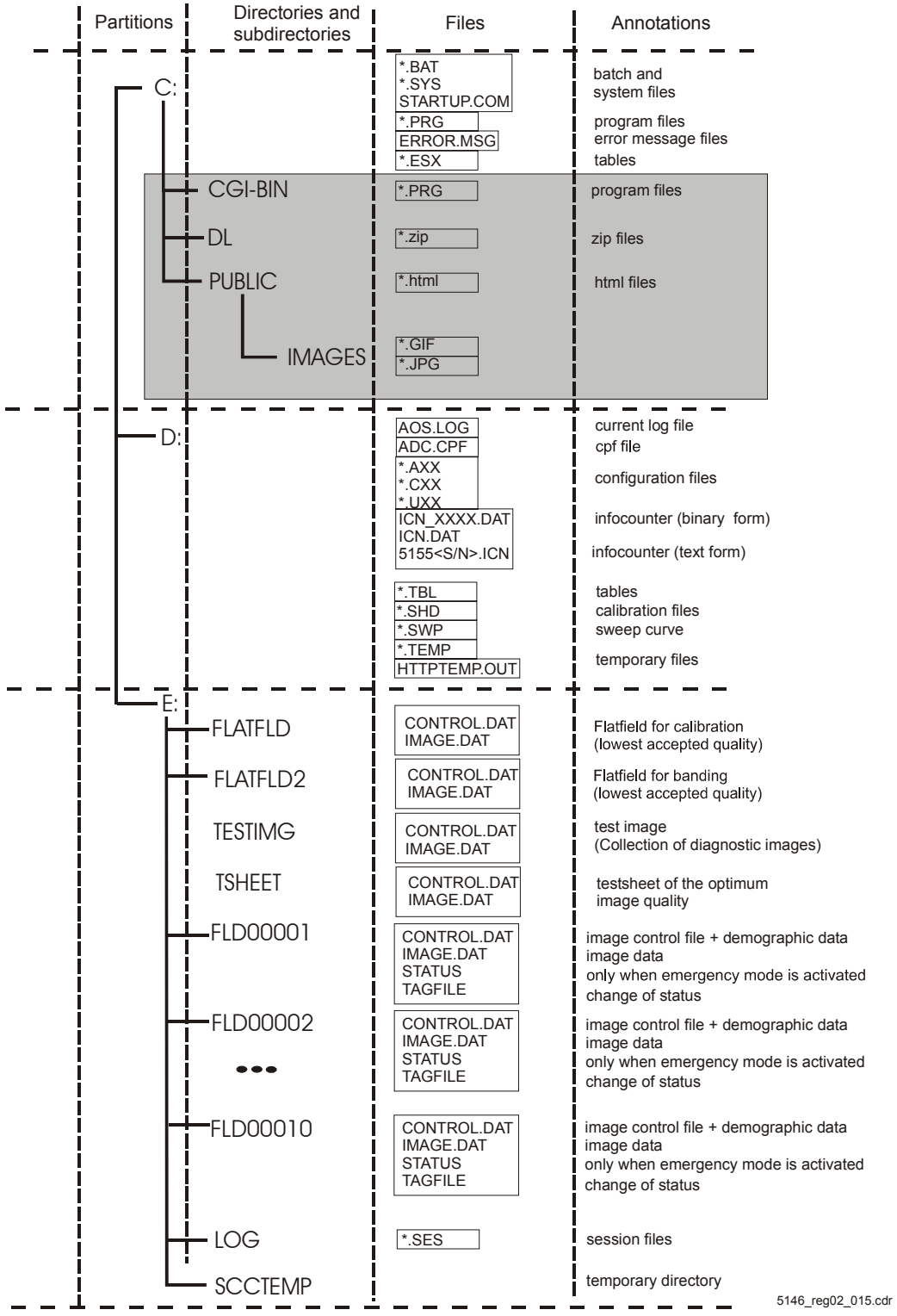


Figure 15

3.6 Cassette Unit 1 / 2

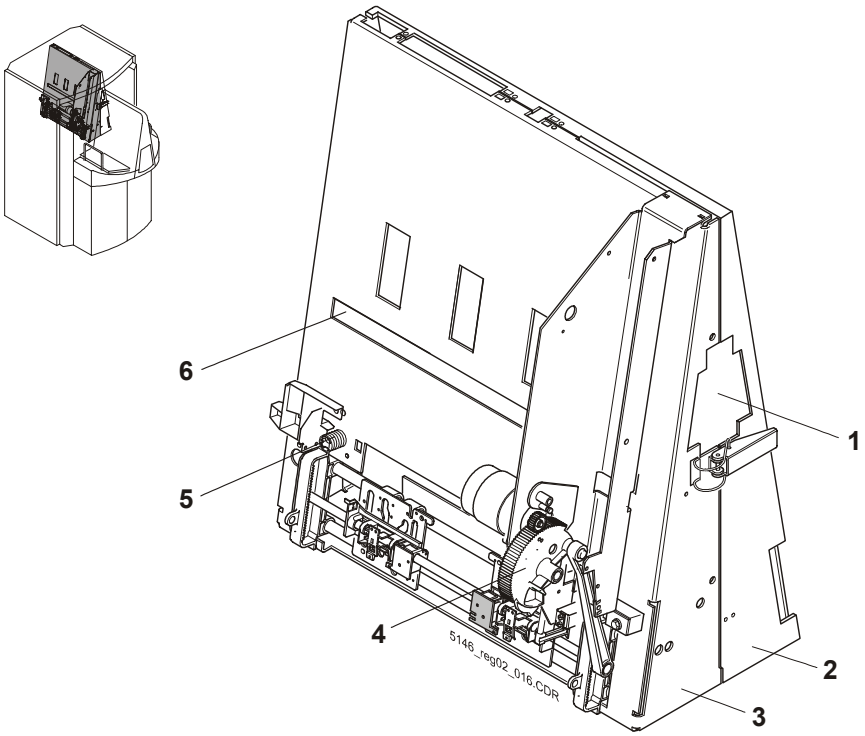


Figure 16

1 5fold stepper motor boards (inside)
2 Cassette Module 2
3 Cassette Module 1
4 Opener mechanism
5 Transport roller
6 Transport belt

The Cassette Unit 1 or 2, depends on which one is at the input buffer, fixes and holds the cassette during the IP is taken out and scanned. An opener mechanism for the cassette is also part of each unit. The Cassette Units 1and 2 together are supported and turned by the rotation unit.

On the inner side of each of the Cassette Units is a 5fold stepper motor board placed, which controls the motors of the corresponding unit.

3.7 IP Transport Unit Prescan

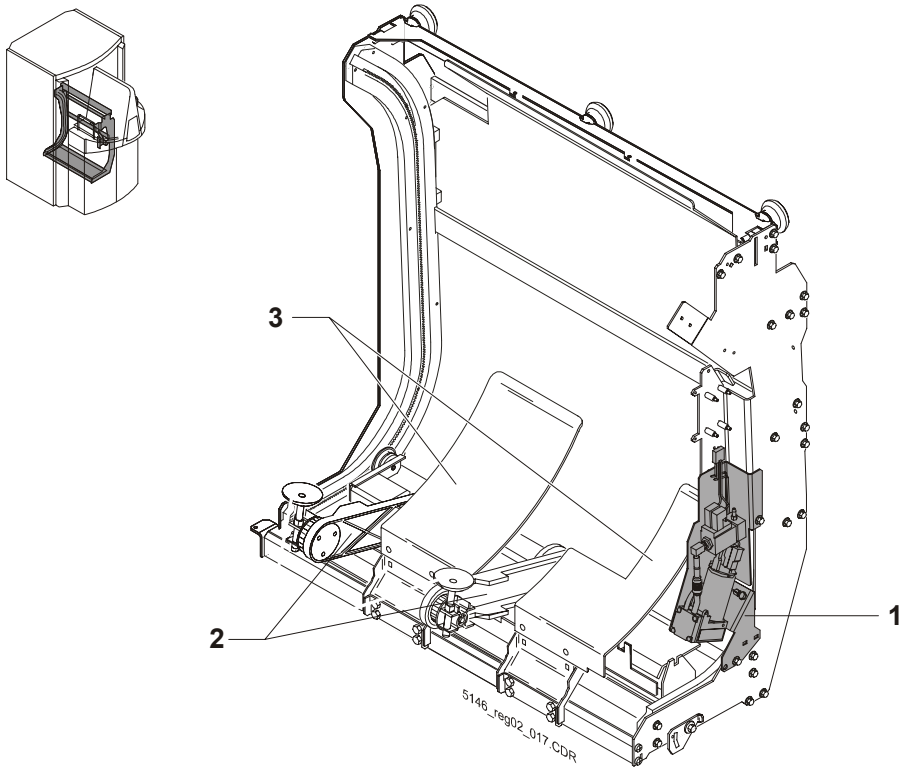


Figure 17

1 Vacuum unit
2 Suction arms
3 Guide plate

The IP transport robot takes the IP out of the cassette and leads it along the guide plate to the optic module. The transport robot is guided in the frame of the unit.

3.8 Rotation Unit

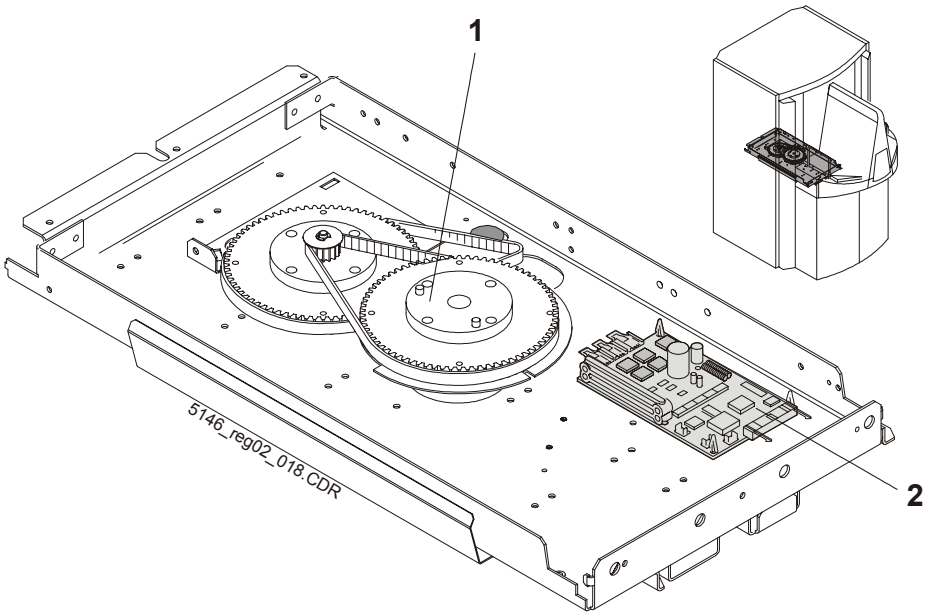


Figure 18

1 Rotational drive
2 Stepper motor board

Rotates the Cassette Units by 180° to bring the empty cassette of the input side to the output side, for putting back the scanned and erased image plate inside the cassette.

3.9 Scan Unit

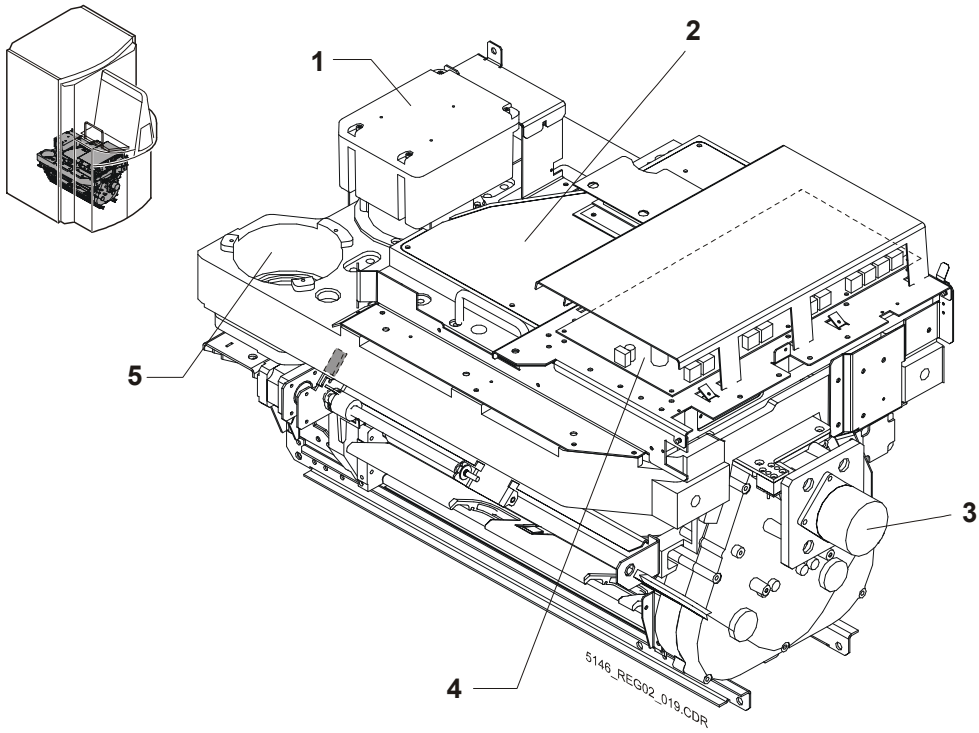


Figure 19

1 Photomultiplier
2 Optic module
3 Slow scan motor
4 5fold st scan
5 Holder for a second Photomultiplier

The function of the scan module is to stimulate a two dimensional, X-ray exposed, image plate which is made of phosphor with laser energy. Out of the blue light, which is emitted by the phosphor, a digital image is generated.

The stimulation of the image plate is done pixel by pixel, therefore the laser beam is moved. The laser power on the focal plane is 60 mW $\pm$ 5%. The movement in the x-axis is achieved by a rotating polygon mirror (fast scan direction) which is part of the optical path. The movement in the y-axis is done mechanically by transporting the image plate (slow scan direction) with two pairs of rolls.

3.9.1 Laser Diodes

The optic module contains a monochromatic anamorph scan optic where the laser beam is modified. The light source which is stimulating the image plate are two red laser diodes, with a wavelength from 650 nm to 670 nm and a maximal output of 50 mW each (see **2** in figure 20) . The increase and

decrease time of the laser power is shorter than 20 µs. The two beams of the laser diodes are optical superposed to one and this is focused to have a spot diameter of 60 µm on the scan surface.

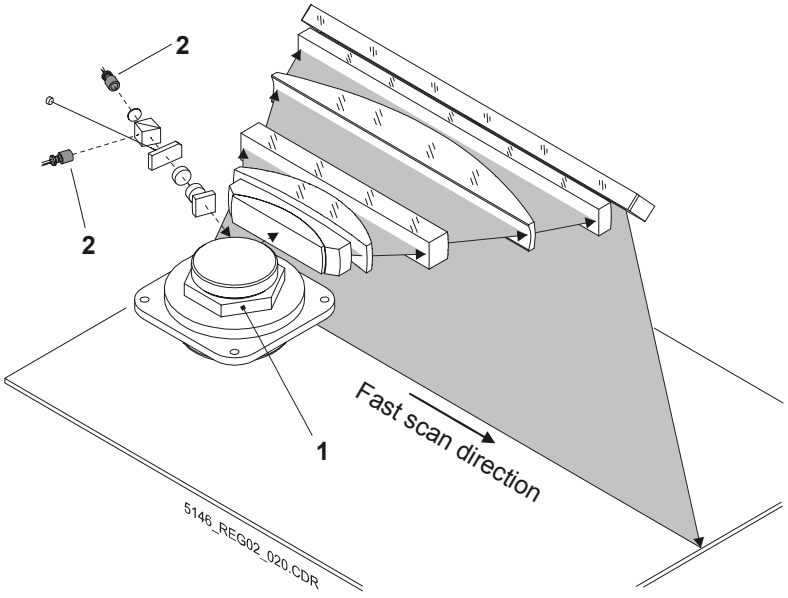


Figure 20

3.9.2 Polygon

The Polygon has 6 facets, each with a mirror (see **1** in figure 20). It is turned by a DC motor which is clock pulsed fromthe scanning hardware. Pixel times between 2.5 and 0.6 µs can be reached, but for scanning are two times used, 1 and 2 µs.

3.9.3 Photomultiplier (PM)

The light collection is done by two bundles of glass fiber and the light detection is done by a photomultiplier tube, which generates an electrical signal out of it. The light from the input of the photomultiplier is converted into a proportional current on the output.

The amplification of the signal is set by the high tension voltage (HT) of the photomultiplier. The high tension is calculated with two mathematical constants MFA and MFB (machine factor A and B). The constants are part of the settings of the digitizer and do not have to be changed in the field. The high tension supply is integrated in the photomultiplier box.

The photomultiplier is equipped with a blue filter glass for separating the emitted blue light from the stimulating red light. For self tests a blue LED is mounted at the back side of the PM.

3.9.4 Optic Module Housing

The housing is made of cast aluminum witch is electrical isolated to the ground plate. The cover is made of conductive material to achieve electromagnetic compatibility (EMC). The housing of the optic module stays closed in the field and no service needs to be done inside.

3.10 Erasure Unit

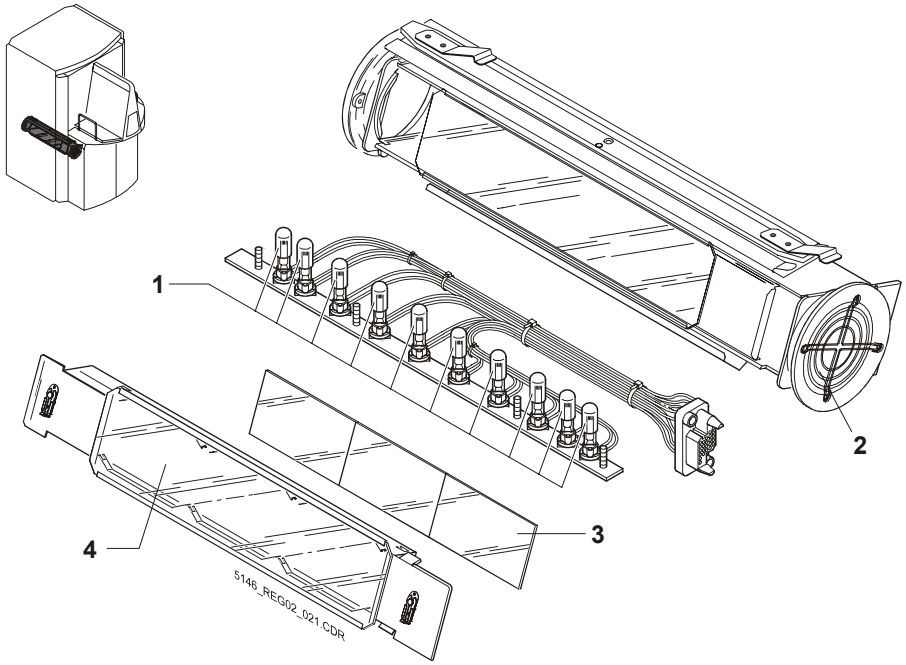


Figure 21

1 Halogen lamps (Osram Xenophot HLX64623 12V, 100 Watt, commercially available)
2 Grid for cooling by erasure unit fan
3 KG2 filter for heat protection
4 Front glass (UV filter with sensitive gelatin layer)

The lamps are controlled by the erasure control board and the CS board. The lamps are controlled during work in pairs and also the power supply of 12 V is generated via 5 single transformer. By initialization of the digitizer every lamp is controlled separately. For erasing the image plate a power input of in total 1000 Watt with 230V / 50Hz is present.

The erasure unit fan (placed in the cPCI Rack) is switched on from the MS board at the same time the lamps are switched on. After the last scanned and erased image plate the fan is running a certain time for cooling down the unit.

The lamps are already switched on for 0.5 s before the IP reaches the erasure window. The speed the IP is transported past the erasure unit is varied between image plate begin and end for optimized homogeneity – dependent on speed class and format (Erasure energy per time is determined by means of the demographic data). An image plate format of 35 x 43 cm is transported centered past the erasure front glass. The maximal distance from image plate to erasure front glass is 20mm + 5mm.

Erasing process is not taking place if scan is in progress or the temperature switch is detecting to high values and interrupts for a cooling delay.

3.11 IP Transport Unit Postscan

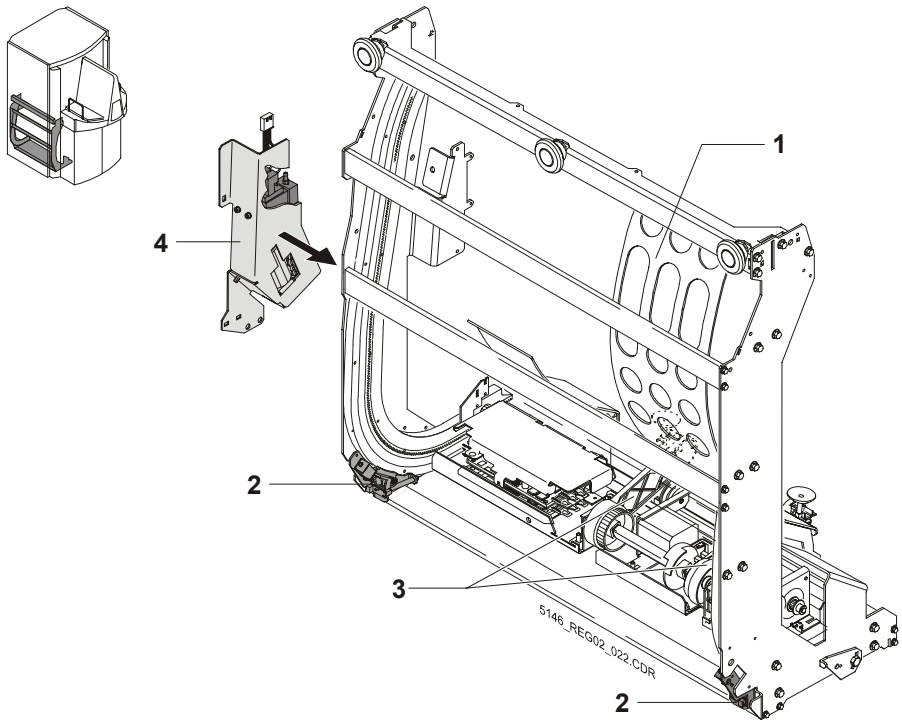


Figure 22

1 Guide plate
2 Rocker for parking position
3 Suction arms
4 Vacuum unit

The IP transport robot leads the IP along the guide plate and puts the IP back to the cassette in the cassette unit.

The transport robot is guided in the frame of the unit. To move the suction arms back in working position without a conflict with the next IP coming out of the scanner, the robot is moved in a parking position.

4 Cycle of a Cassette in the Digitizer

4.1 Input Buffer

4.1.1 Starting the Machine Cycle by inserting a Cassette

An ADC Cassette with an exposed Image Plate (IP) inside is set in correct orientation into the input buffer.

The light barrier GS516 (long distance light barrier) recognizes the cassette and starts the mechanical process of the digitizer.

A belt drive, moved by motor M514, retracts the cassette and the feed gate opens, run by motor M513.

The light barrier GS518 detects when the cassette is retracted.

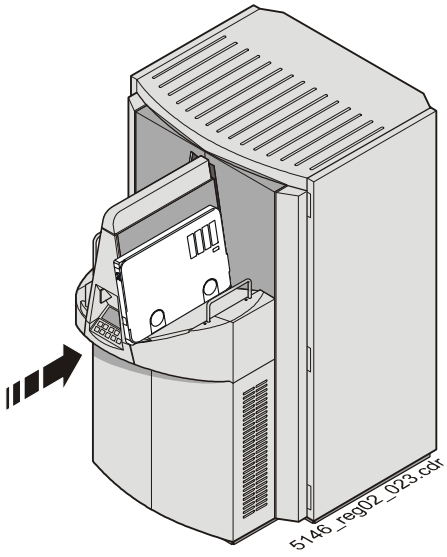


Figure 23

4.1.2 Identification of the Cassette and reading the ID-Data

The silver dot at the bottom of the ADC Cassette is identified by the reflex light barrier GS540. If no dot is detected the cassette is refused.

The ID-Data are read out from the chip on the cassette by the RF tag antenna GS538 (1) and the corresponding board (2).

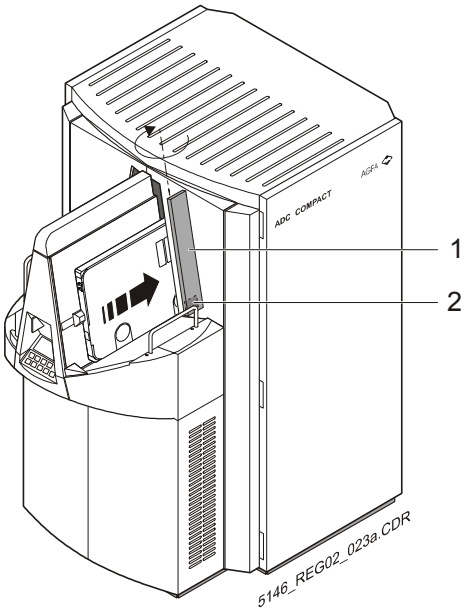


Figure 24

4.2 Cassette Unit 1/2

4.2.1 Taking Cassette in the Cassette Unit

The transport roller (2), moved by motor M201/M206, brings the cassette completely into the cassette unit.

The light barriers GS220 / GS270 recognize the cassette and start the belt motor M205 / M210 to transport the cassette.

The light barrier GS222 / GS278 (long distance light barriers) (1) detects when the cassette is retracted to the cassette unit.

The light barrier GS224/GS274 (3) activates the clamping mechanism.

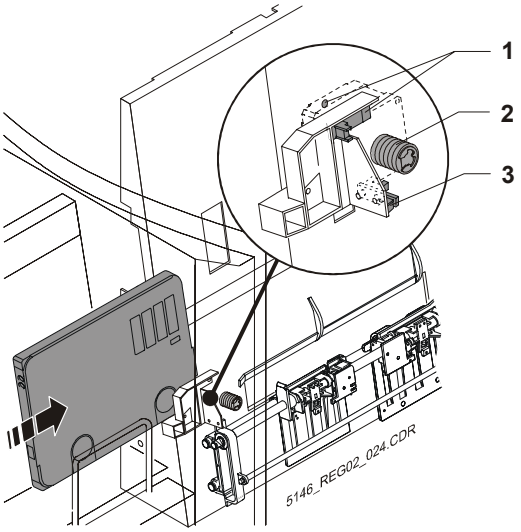


Figure 25

4.2.2 Clamping the Cassette

The cassette is lowered by M202/M207 when a signal of the light barrier GS214/GS265 comes in.

In the lowered position the light barrier GS224/GS274 for starting the clamp mechanism detects the cassette. The clamp motion is run by M203/M208.

The light barrier GS230/GS280 detects when the cassette is clamped.

In the clamped position the light barrier GS228 / GS277 detects the start for the opening mechanism (2).

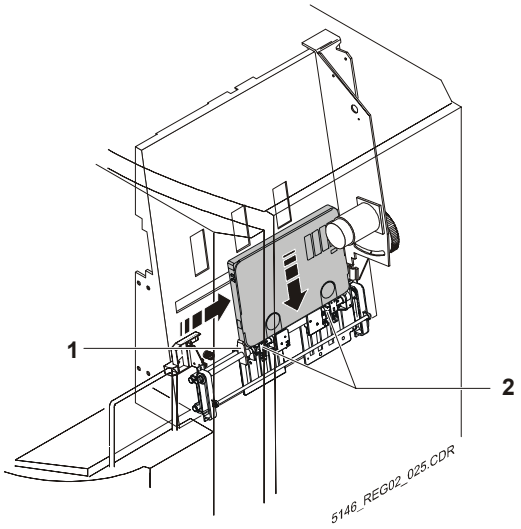


Figure 26

4.2.3 Opening the Cassette

The cassette lid is opened by the stepper motors M204/M209 with a certain number of steps.

The cassette stop switch GS226/ GS276 is set.

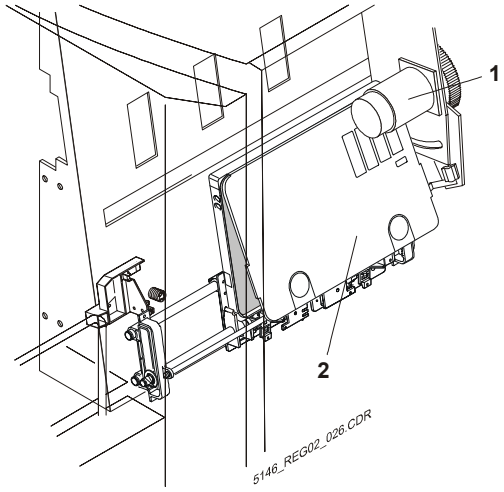


Figure 27

4.3 IP Transport Prescan

4.3.1 Positioning of the Transport Robot

Transport robot prescan moves out of start position, detected by GS432, upwards to the cassette unit by motor M403. The working position of the robot is detected by GS430.

The suction arms (1) are moved in the right position by motor M402. The positioning of the suction cups on the IP (2) is detected by GS 426 and GS424.

The vacuum pump GS420 (3) starts to build up low pressure.

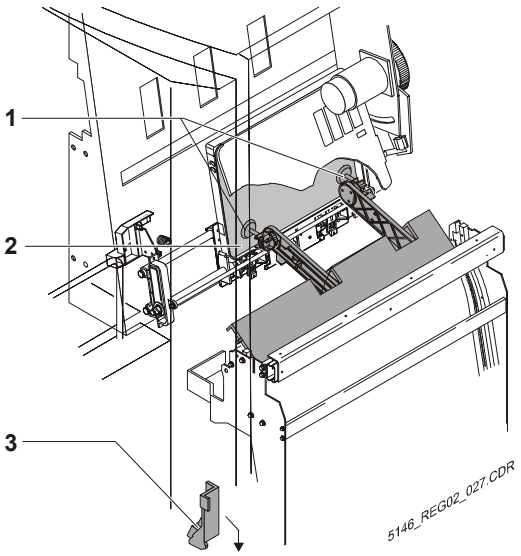


Figure 28

4.3.2 Taking out the IP

By opening the magnetic valve MG422 the vacuum is transferred to the suction cups and the IP is sucked.

The IP is taken out of the cassette and moved down to the scan unit by motor M403.

By passing the light barrier GS432 the scan rollers open and start to turn, driven by motor M621.

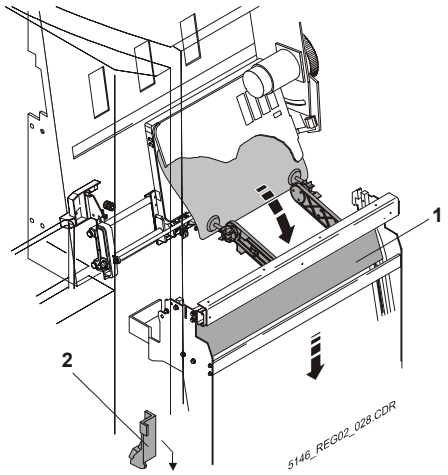


Figure 29

4.3.3 Transporting IP to the Scanner

The transport robot prescan transports the IP to the scan unit.

The vacuum stops, the IP (2) is falling down and is guided to the scan rollers (1).

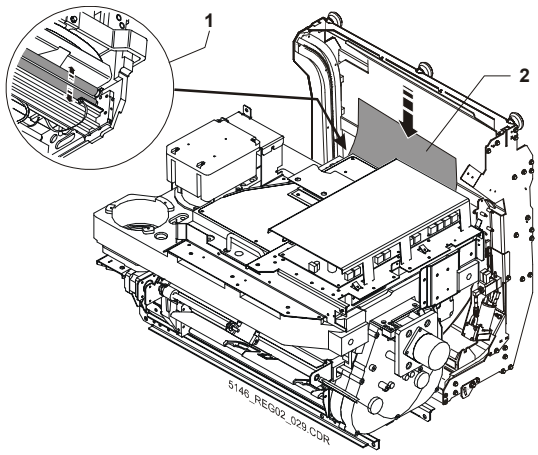


Figure 30

4.4 Rotation Unit

While the IP is scanned the cassette unit is turned 180° by M212. The starting position is detected by GS206, the final position after turning by GS204.

The cassette itself stays clamped on the same cassette unit.

Therefore the IP returns after the scan and erasure process into the same cassette it was placed before.

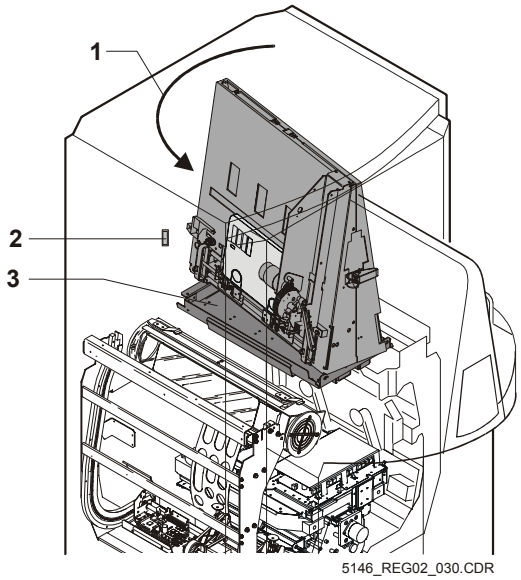


Figure 31

4.5 Scan Unit

4.5.1 Positioning of the IP

The IP is positioned for the scan process by motor M622 moving the alignment fingers (1). The position is checked by light barrier GS616.

The IP is loaded into the scan unit and the slow scan process is started by GS626 (long distance light barrier), giving the begin of scan signal (BOS).

If also the begin of line signal, activated when the laser touches a PIN diode inside the optic module, is given the scanning starts.

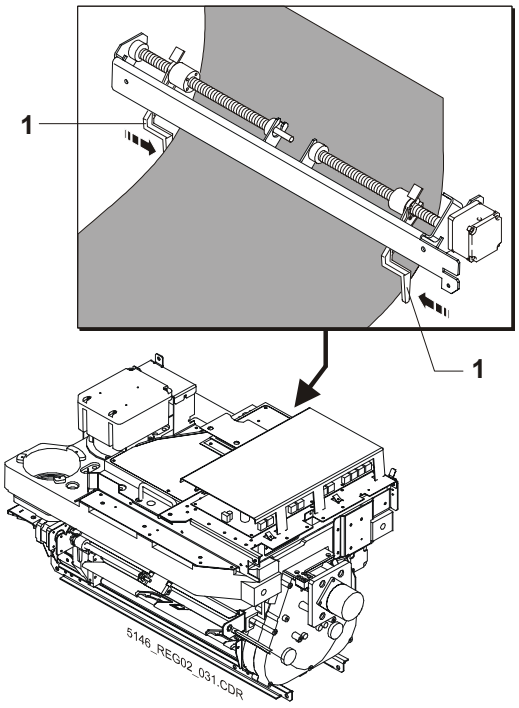


Figure 32

4.5.2 Scanning the IP

The IP is moved through the scanner by M702.

The scan process is split into a fast and a slow scan direction.

The laser power of the laser diodes are lead to the IP via optical lenses and a polygon. The light emitted from the IP is transferred by two fiber optics to the photo multiplier.

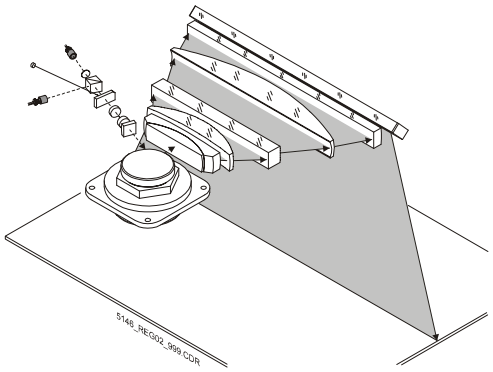


Figure 33

4.5.3 Unloading the IP from Scan Unit

After the scan process, the IP is detected by GS614 (2) and positioned by motor M612 moving the alignment mechanics (1). The position is controlled by light barrier GS612.

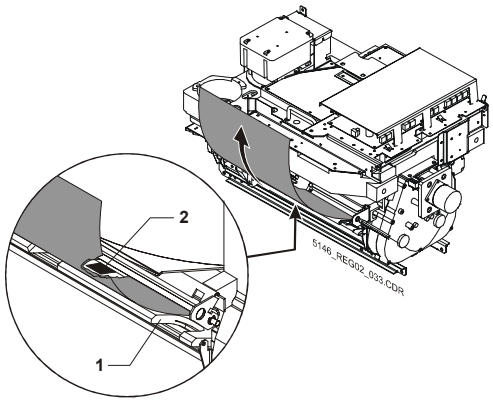


Figure 34

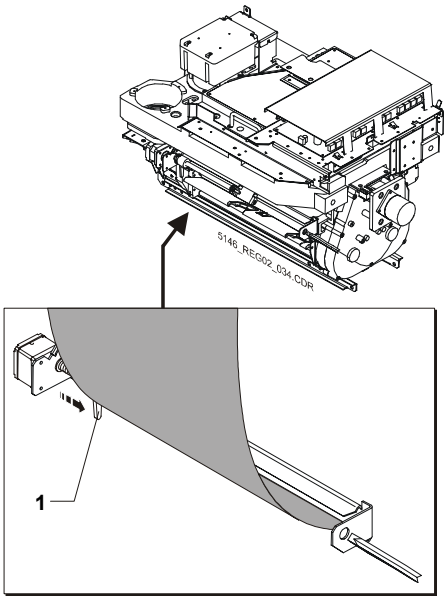


Figure 35

4.6 IP Transport Postscan / Erasure Unit

4.6.1 Positioning of the Robot

The transport robot postscan is moved by the motor M401 out of the start position, detected by light barrier GS416, into working position controlled by GS414. This movement is shown in the upper cycle of figure 35. (The other movement is worked out after the IP is put back into the cassette.)

The suction arms are positioned by motor M400. The start position of the suction arms is detected by the light barrier GS410 and the final position of GS408.

The vacuum pump GS402 of the transport robot postscan starts.

To suck the IP the magnetic valve MG411 is opened.

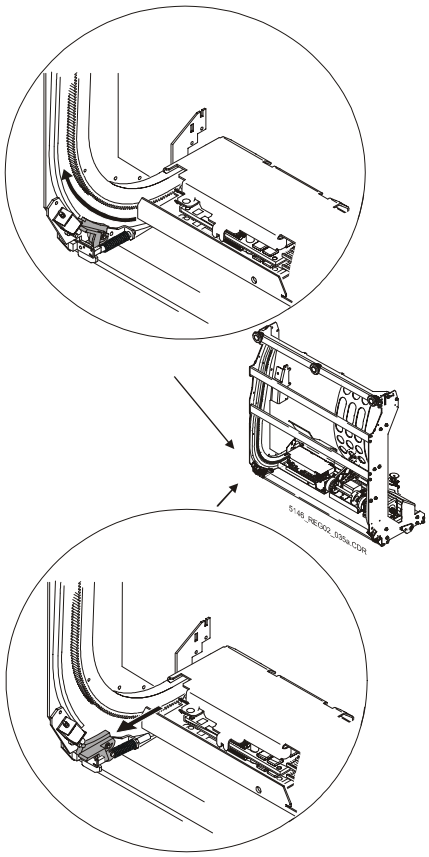


Figure 36

4.6.2 Transporting the IP to Erasure Unit

The IP (1) is moved by motor M401 of the transport robot postscan to the erasure unit (2).

The erasure process starts, if there is no cooling delay necessary.

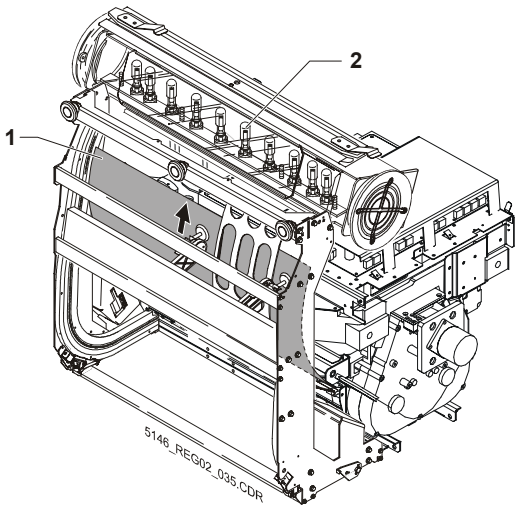


Figure 37

The IP passes the erasure lamps (3) in a certain speed. The speed is dependent on the format of the cassette. This information is given by the chip on the Cassette and was read out at the beginning of the cycle.

There are different speeds to vary homogeneity and intensity of the erasure effect on the IP.

The image information (2) on the IP is erased and the blank IP (1) can be used for another X-ray exposure.

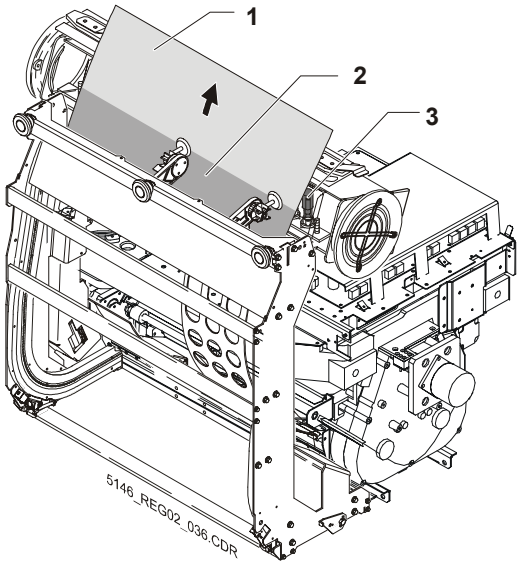


Figure 38

4.6.3 Putting the IP back into the Cassette

The suction arms of the transport robot postscan put the IP back into the cassette.

The vacuum stops and the suction cups are sliding away from the IP.

The direction of the movement see the arrows in figure beside.

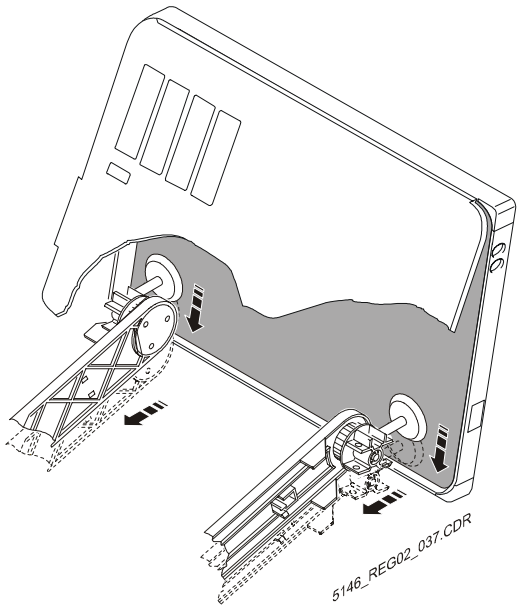


Figure 39

The suction arms are moving away from the IP, driven by motor M400 (1) and the robot goes back to parking position by M401 (2).

The way to the parking position is guided by opening the two magnetic valves MG401 and MG402 on the guiding rail of the transport unit frame.

The parking position is detected with one light barrier on each side, GS404 and GS406. This movement is shown in the lower cycle of figure 35.

In this position the suction arms are moved to the right angle to take the next IP.

The robot moves finally in start position to wait for the next IP.

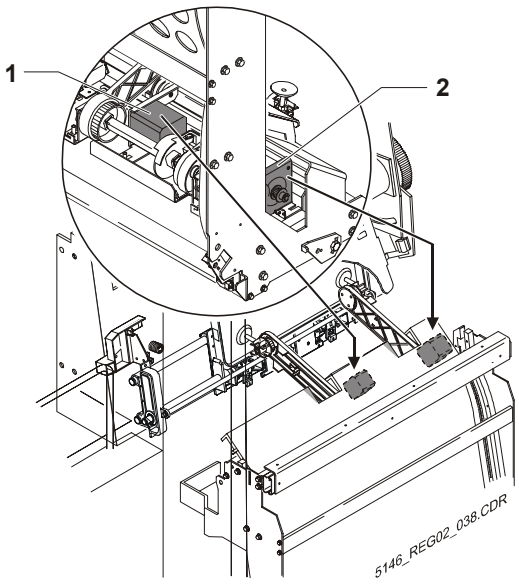


Figure 40

4.7 Cassette Unit

4.7.1 Moving Cassette to Output Buffer

Closing, unclamping and lifting the cassette upwards, works in reverse order than described at 4.2.2 and 4.2.3 of this chapter.

The cassette is closed by motor M204/M209 and the closed status is detected by light barriers GS228/GS277.

The clamping (1) is removed by motor M203/M208 and detected by light barriers for clamping position GS230/GS280 and start position GS224/274.

The motor M202/M207 of the cassette unit transports the cassette upwards.

The transport belt is turned by M205/M210 to move the cassette to the output buffer. The position of the belt is detected by the light barrier GS220/GS270.

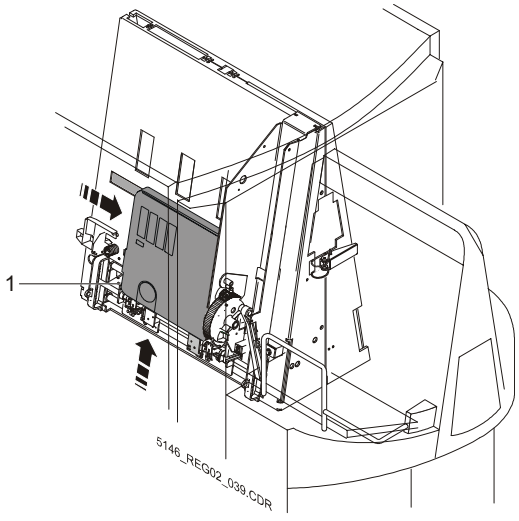


Figure 41

4.8 Output Buffer

4.8.1 Transporting the Cassette to output

The transport belt of the cassette unit (1) moves the cassette to the output buffer.

The cassette is detected at the output buffer by GS558.

The transport roller, powered by motor M515 and controlled by light barrier GS564, brings the cassette outside the output buffer.

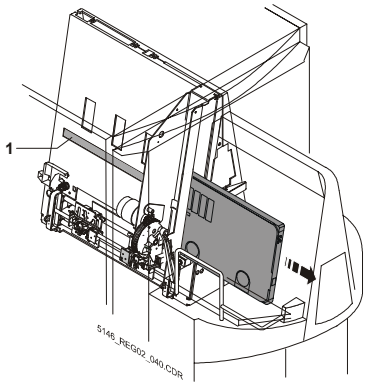


Figure 42

4.8.2 Putting out the Cassette

The light barrier GS560 (long distance light barrier) recognizes the end of the cassette cycle.

To avoid a blockade of cassettes by scanning one after another, the lever (1) of the output buffer, controlled by light barrier GS554 and powered by motor M516, pushes the out coming cassette aside.

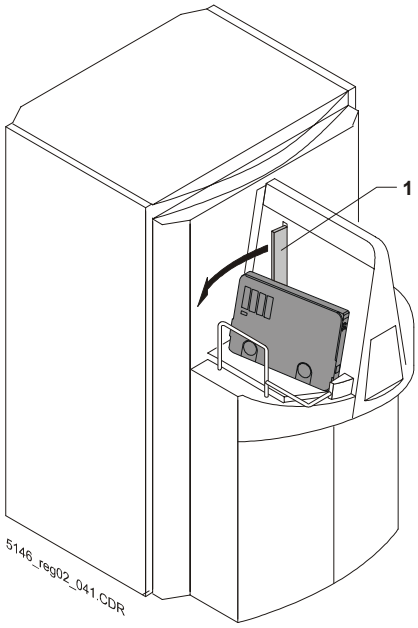
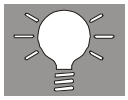


Figure 43



5 Software Architecture

5.1 Diagnostics Software

The Diagnostics Software is a tool which helps to find defective parts in the digitizer. A dialog with requests and questions via the display guides you through the test of a module.

All components of a module (light barriers, boards, motors, valves, mechanics…) are checked during a test. If the result is satisfying, the module is working in a normal operating mode. If a problem is detected a problem description and a repair proposal comes up on the display.

Modules tested by Diagnostics Software:

Input buffer and R/F-TAG	Opens input door and moves cassette to position 'silver dot detection'; tests R/F-Tag reading and writing. Identified cassette 35x43 cm is for this test needed!
Cassette module 1	Turns cassette module 1 to right side; opens, clamps and closes cassette; turns cassette module 1 to left side and shifts cassette out. A cassette 35x43 cm is for this test needed!
Cassette module 2	Turns cassette module 2 to right side; opens, clamps and closes cassette; turns cassette module 2 to left side and shifts cassette out. A cassette 35x43 cm is for this test needed!
Rotation unit	Turns cassette module 1 to right side and then cassette module 2 to right side.
Prescan transport+vac.	Opens cassette on right side; tests prescan valves, vacuum pump and vacuum switch; moves robot up to cassette module; sucks image plate and releases it again; moves robot down to scanner; closes cassette again. A cassette 35x43 cm with an image plate inside is for this test needed!
Scanner	Turns scanner rollers; moves pre-/post-alignment drives and rollers-lift home.
Postscan transport	Clamps cassette on right side and turns cassette to left side; tests postscan valves, vacuum pump and vacuum switch; moves robot up to

	cassette module; sucks image plate and releases it again; moves robot down to scanner; closes cassette again and shifts cassette out. A cassette 35x43 cm with an image plate inside is for this test needed!
Erasure unit	Switches on fan, then switches on upper left lamp, upper right lamp and lower lamp separately; tests if thermo-switch switches off in case of high temperature.
Image transmission	Checks which destinations (DIPS) are responding, sends the test image to all responding destinations and checks the result of the image transmission. Considers rerouted destination.

5.2 Web Pages

The Software of the digitizer allows access from the Internet to the service level of the machine. The access via a graphic User Interface (ADC web pages) is part of the service concept of MI CSO. The web pages follow the structure of the well-known User Terminal.

Access via web pages guarantees a convenient and fast service by making use of standard tools. The usage of different ports for these ways allows working simultaneously with FTP, HTTP, and TelNet.

Further information, see Section 3.2 / 7

5.3 Hardware Modification Floppy of Spare Part

Spare parts which are sent with a floppy, need to be included in the system via software. The floppy e.g. of the optic module contains specific settings of production calibration and data of the spare part. This information need to be installed after the spare part is mounted in the digitizer. For other spare parts sent with a floppy only the information for the info counter is included.

The floppy is put into the floppy drive of the cPCI-Rack and the installation starts automatically. The information concerning the spare part is integrated in the system.

6.2 Data Flow

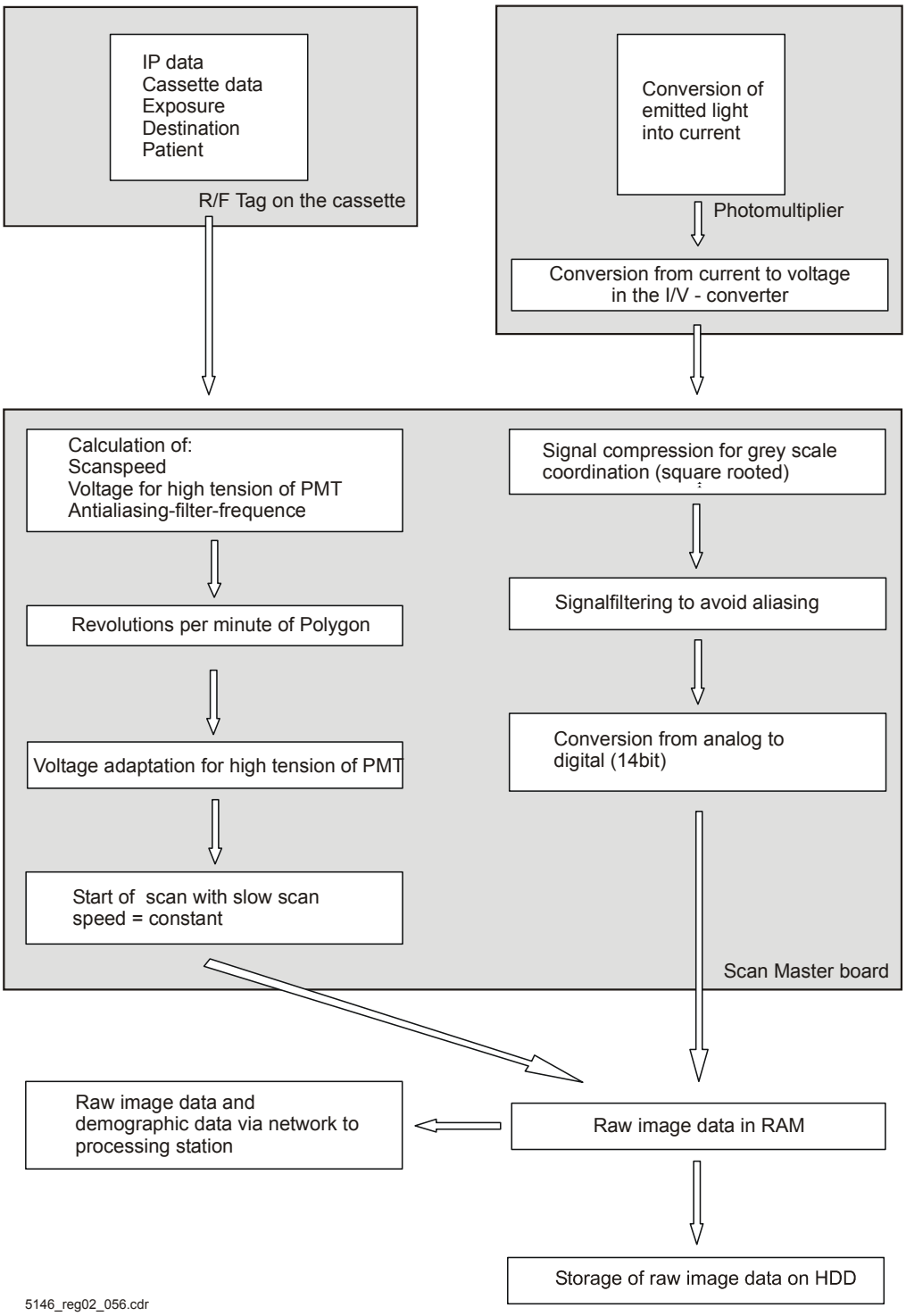

IP data
Cassette data
Exposure
Destination
Patient
R/F Tag on the cassette
Conversion of emitted light into current
Photomultiplier
Conversion from current to voltage in the I/V - converter
Calculation of:
Scanspeed
Voltage for high tension of PMT
Antialiasing-filter-frequence
Revolutions per minute of Polygon
Voltage adaptation for high tension of PMT
Start of scan with slow scan speed = constant
Signal compression for grey scale coordination (square rooted)
Signalfiltering to avoid aliasing
Conversion from analog to digital (14bit)
Scan Master board
Raw image data and demographic data via network to processing station
Raw image data in RAM
Storage of raw image data on HDD
5146_reg02_056.cdr

Figure 45

7 Calibration Principle

There are two different calibrations to work out with the ADC Compact Plus in the field. The IP Center Calibration, which is necessary after replacement of the optic module or a change on the mechanical adjustment of the begin of scan sensor, and the shading calibration which is responsible for the image quality and follows always after an IP Center Calibration.

7.1 IP Center Calibration (BOL/BOS Adjustment)

The IP center calibration adjusts two different scan signal settings in one process, the **b**egin **o**f **l**ine (BOL) signal for the fast scan direction and the **b**egin **o**f **s**can (BOS) signal for slow scan direction. Both signals in combination are responsible for the area which is scanned and where pixels are created.

7.1.1 BOL

The BOL sensor is a pin diode placed in the optic module. It controls the switching off and on of the laser. The sensor is beside the IP, therefore the laser beam hits the sensor before the IP. Out of the defined distance between the sensor and the border of the IP the moment of reading out the pixel lines on the IP is set.

7.1.2 BOS

The BOS sensor is a long distance light barrier which is placed at the bottom part of the scan unit. The light barrier gives the signal to start the scan process in slow scan direction. When the IP reaches the sensor it is detected and then passes a fixed distance to the begin of scan line, then the scan process starts.

7.1.3 Calibration Procedure

The IP center calibration is worked out with an IP format smaller than 35 x 43 cm. In reference to this biggest format the borders around the scanned IP are detected.

The distance corresponding to the BOS signal is measured from the geometrical reference to the border where the scanning of the IP starts. The ideal distance is defined with 5 mm.

The both distances measured to adjust the BOL signal must be equal, means the IP is scanned in centered position.

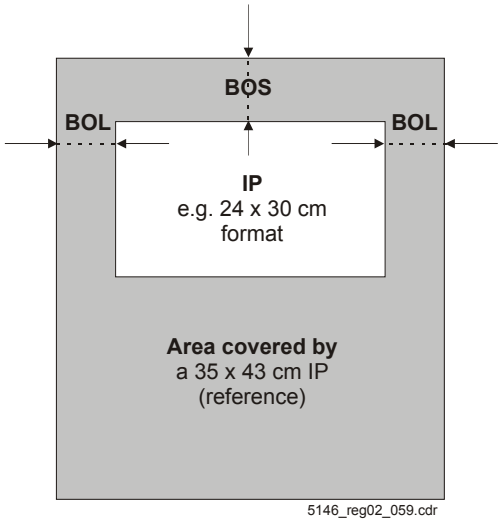


Figure 46

7.2 Shading Calibration

Inhomogeneties of the light collector (fiber optics) and the photomultiplier require a position dependent calibration of the scan line. This pixel wise line calibration evens out differences in the transmission behavior of the glass fibers by calculation.

Each scanned pixel in a line is corrected arithmetically by its corresponding correction value (shading correction). This is done for each of the three speed classes 600, 200, and 75.

A number of lines of a flat field image are averaged and scaled to the maximum pixel value. All the lines need to be in a certain range to make the calibration successful, if not the error is displayed at the user terminal.

The calibration curves can be viewed by using a web browser. (see chapter 3.2)

Three curves for each format are displayed in one image and distinguished by three different colors.

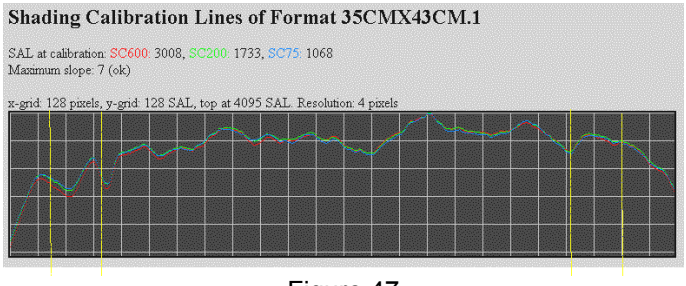

Shading Calibration Lines of Format 35CMX43CM.1
SAL at calibration: SC600: 3008, SC200: 1733, SC75: 1068
Maximum slope: 7 (ok)
x-grid: 128 pixels, y-grid: 128 SAL, top at 4095 SAL. Resolution: 4 pixels

Figure 47

The y-axis of the coordinate system shows the **S**can **A**verage **L**evel (SAL) which is the digital value (gray scale) of a pixel and is one of the criteria for a successful calibration. The x-axis shows the number of pixels.